THE OCCURRENCE AND DISTRIBUTION OF *HIEROCHLOË ODORATA* IN OHIO[1]

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Hierochloë odorata (L.) Beauv. is the sweet smelling grass that the Indians of the Traverse Bay region of Michigan use in making souvenir baskets and other woven articles. In northern Europe, where the species also occurs, its leaves were formerly scattered in front of church doors on saints' days, and Icelandic maidens

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placed bundles of *Hierochloë* leaves among their linens to serve as natural sachets. The lingering fragrance, which accounts for these uses, is due to coumarin, and is responsible for such colloquial names as Sweetgrass and Vanilla Grass.

Hierochloë odorata is rather widely distributed in the Northern Hemisphere, occurring in both the Old and New Worlds. In North America it is confined chiefly to areas north of the fortieth parallel, although it has been found also in the mountains of Arizona and New Mexico. Throughout this range it is extremely local and is represented by scattered populations in moist habitats.

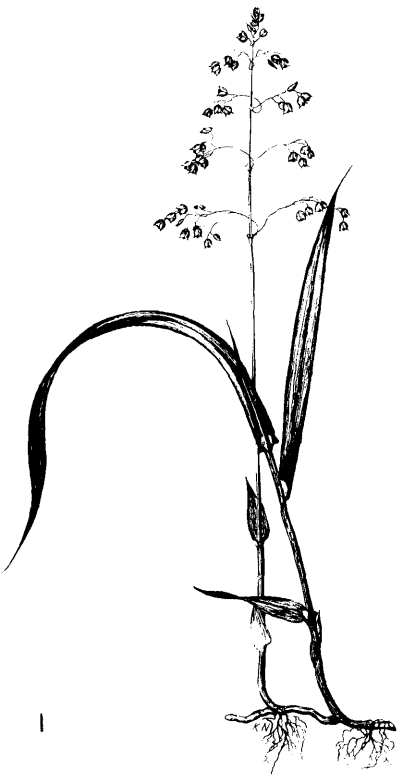

FIGURE 1. *Hierochloë odorata* (L.) Beauv. var. *fragrans* (Willd.) Richter.

Norstog (1957) has previously reported the occurrence of polyembryony and possibly apomixis in the reproductive cycle of the species. The present study is, in part, an extension of that former investigation, and has as its objective the analysis of the occurrence, distribution, chromosome numbers, and reproduction of populations of Sweetgrass in Ohio.

MATERIAL AND METHODS

Information on the distribution of *Hierochloë odorata* in Ohio was obtained by means of a postcard survey of college and university herbaria within the state and of various herbaria in other states. The data obtained as a result of these contacts are summarized in figure 2.

Whenever the descriptive information accompanying herbarium specimens of Sweetgrass was specific enough, the areas in which the original collections had been made were revisited. In some instances, of course, it was obvious that such

trips would be completely fruitless. For instance: three herbaria, the Gray Herbarium of Harvard University, the New York Botanical Garden, and the Herbarium of The Ohio State University, have specimens collected in Columbus, Ohio in the early 1800's when that city was only a village. Now the only place in the metropolis where Sweetgrass occurs is the Herbarium of The Ohio State University.

Additional field trips were undertaken in the hope of discovering new locations. In all, seven populations of Sweetgrass were located, two for the first time. Plants from these areas subsequently were removed to the greenhouse of Wittenberg University for further study. The soil and roots of these transplants were wrapped in cheesecloth and suspended in clean clay pots which were, in turn, set in shallow

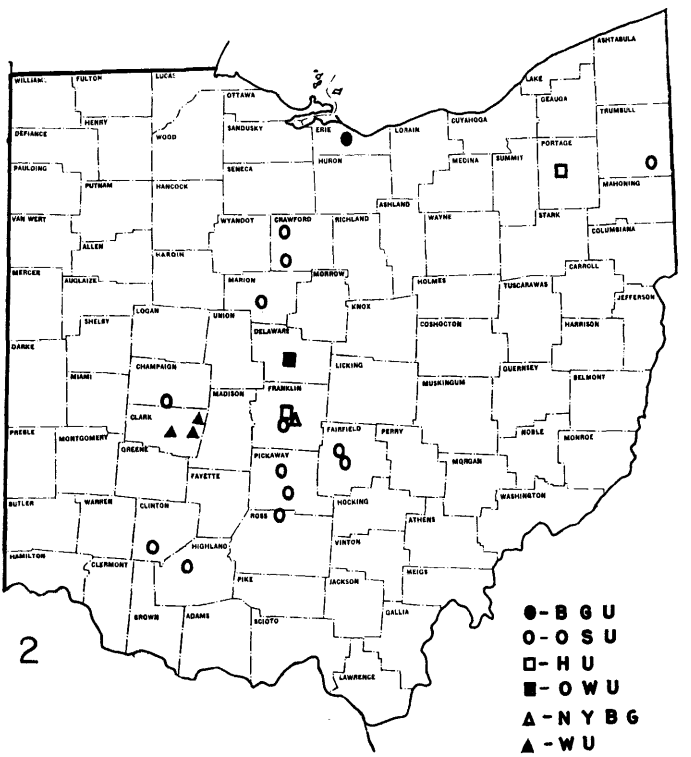

FIGURE 2. Locations of populations of *Hierochloë odorata* which are represented by herbarium specimens. BGU—Bowling Green State University, OSU—The Ohio State University, HU—The Gray Herbarium, Harvard University, OWU—Ohio Wesleyan University, NYBG—Herbarium of New York Botanical Garden, WU—Wittenberg University.

pans of water. After a time, the soil-free roots which grew through the cloth were removed and processed by a technique suggested by Sigurbjörnsson (personal communication). In this method the root tips are collected in mid-afternoon, immersed in distilled water, and placed in a refrigerator. This treatment holds the cells in the metaphase and also tends to separate the chromosomes. The following morning the root tips are placed in Farmer's fluid for at least 30 minutes and then removed, as needed, to a small beaker containing 5 ml of aceto-carmine solution and one drop of concentrated hydrochloric acid. This is heated to

boiling momentarily and allowed to cool. The terminal millimeter of the root tip is placed in a drop of aceto-carmine on a slide, teased apart with a steel needle, and squeezed under a coverslip. This method has produced better results with *Hierochloë* root tips than any other method recommended for such recalcitrant material as the root tips of grasses.

In addition to the collections of living plants, specimens were also collected and preserved by drying for use in the determination of relative fertility and the occurrence of polyembryony. This was done very simply by counting the florets in a number of inflorescences, threshing these through sieves, and examining the separated caryopses under a dissecting microscope.

OBSERVATIONS

It has become evident that *Hierochloë odorata* has a rather limited distribution in Ohio, not only in terms of the number of separate populations but also in the number of plants per stand. It should be remembered that only two new locations, both in Clark County, have been added to the total for Ohio as a result of the present study in spite of an extensive search.

FIGURE 3. Somatic chromosomes from root tips of *Hierochloë odorata*, specimens from Champaign County, camera lucida tracing, arrows point to long and short pairs of chromosomes referred to in text.

Figures 3 and 4 are representative of the chromosome complements found in the plants from the seven extant populations of *Hierochloë odorata* that were studied. In all instances the somatic chromosome number was found to be 56. A pair of short, apparently telocentric, chromosomes and a long pair were distinguishable in several of the preparations. Some size variation was apparent in the other chromosomes but their tendency to clump interfered with detailed observations of their morphology.

Examination of the inflorescences of specimens from the seven populations revealed that the fertility of Sweetgrass in Ohio is very low. The highest percentage, that found in plants in Marion County, was less than half that reported in plants from southern Michigan (Norstog, 1957). Twin embryos were found to have been produced by plants from five of the seven areas. The absence of

polyembryony in the other two populations may not be significant because of the low fertility encountered. These data are presented in table 1.

TABLE 1

Fertility and polyembryony in Ohio populations of Hierochloë odorata

Area	Total florets	Fertile florets	Fertility	Twin embryos
Highland Co.	526	21	4.0%	6
Ross Co.	280	17	6.1%	0
Harmony, Clark Co.	851	15	1.7%	4
New Moorefield, Clark Co.	1064	20	1.9%	1
Champaign Co.	945	20	2.1%	4
Marion Co.	340	36	10.6%	1
Crawford Co.	757	0	0.0%	0

Hierochloë odorata grows best in places in which it is relatively undisturbed. Its requirement for a constant and high moisture supply limits its survival in Ohio where so many wetlands have been drained, and it apparently cannot withstand intensive grazing, although the reason for this may be a subtle one since cattle are said to find the coumarin taste of the grass rather bitter. None of the populations are very extensive, and the grass occupies a rather sterotyped and

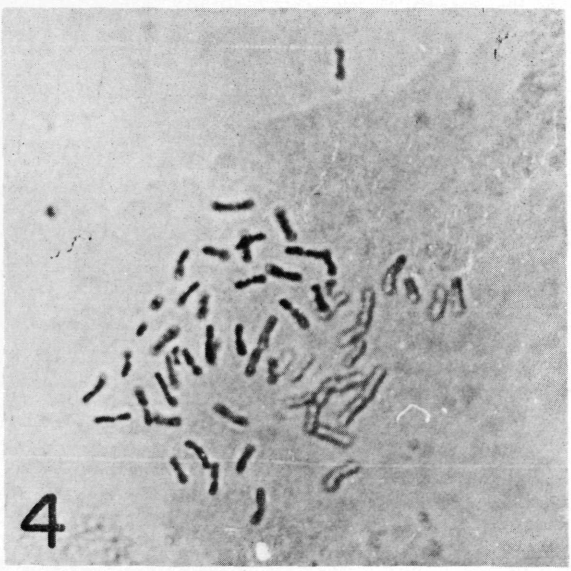

FIGURE 4. Photomicrograph of the original preparation of chromosomes shown in figure 3.

restricted ecological position. Figure 5 represents, diagramatically, the relationships observed in three of the seven areas; the other four were quite similar except that the Big Bluestem Grass, *Andropogon gerardi* Vitman., was absent. Sweetgrass occupies a position in the soil-moisture spectrum between that of plants such as species of *Carex* which grow in shallow water and saturated soils, and the Big Bluestem and others which prefer a dryer substratum. The soils ranged from clay

to muck types, but all were neutral to slightly alkaline, pH 7 to 8. Two of the areas were railroad rights-of-way, and the other five were roadsides. In six of these *Hierochloë* grew only within the right-of-way and did not extend into adjacent farmland, but in the seventh, the Ross County location, the grass also grew along the edges of an undrained marsh. The largest stand was found along U. S. Highway 40, east of Harmony in Clark County. Here the grass grows luxuriantly in the ditch along the north side of the road but not, however, in an adjacent wet meadow which is pastured at present.

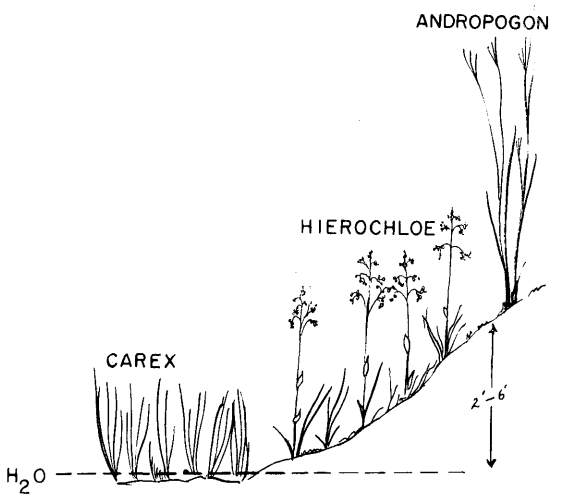

FIGURE 5. Diagram illustrating the habitat relationships of several Ohio populations of *Hierochloë odorata*. Plants shown are an unidentified species of *Carex* in vegetative state, *Hierochloë odorata*, and *Andropogon gerardi*.

DISCUSSION

Fernald (1917), in discussing a tall form of Sweetgrass from Connecticut, called attention to the existence of two varieties of *Hierochloë odorata*. One of these is found in Europe and also in the Rocky Mountain region where, he stated, it intergrades with the eastern race. Fernald designated the latter as variety *fragrans* (Willd.) Richter, pointing out that at one time it was thought to be a distinct species, *Holcus fragrans* Willd. Curiously Fernald later apparently abandoned this separation since in the eighth edition of *Gray's Manual of Botany* (1950) variety *fragrans* is not listed. After examination of collections from Iceland and North America, I feel that two varieties can be distinguished. One of these, to which the Ohio specimens belong (fig. 1), is certainly more robust than the other.

Somatic chromosome numbers of 28, 42 and 56 are listed for *Hierochloë odorata* by Darlington and Wylie (1955). Since the base number in *Hierochloë*, as in many other grasses, is seven, these represent tetraploid, hexaploid and octoploid numbers. Löve and Löve (1955) report that specimens from Iceland, Sweden, Germany, and North America ("at least west to Manitoba") have 28 somatic chromosomes, while the chromosome number is 42 in plants of *H. odcrata* from Russia, Finland, and Japan. The latter recently were identified by Kawano (1959) as *H. odorata* (L.) Beauv. variety *pubescens* Krylov. Church (in Myers,

1947) reported that certain specimens of *H. odorata* had 56 chromosomes. Löve and Löve, however, suggest in this connection ". . . since this last number [56] is also typical for the closely related species *H. alpina* (Sw.) R. & S., it might perhaps have been determined on specimens more correctly referred to that taxon . . . ." Church (personal communication) has assured the writer that the plants on which the determination was made were definitely *H. odorata*. The identical chromosome number in the Ohio specimens confirms this assertion and also seems to justify Fernald's earlier conclusion that two varieties of *Hierochloë odorata* exist in North America. Variety *fragrans* (Willd.) Richter, the robust form having a chromosome number of 56, occurs in the eastern half of the United States and perhaps more widely; variety *odorata*, which is somewhat smaller in size and has a chromosome number of 28, is found in northern Europe, Iceland, Greenland, and northern and western North America.

The question of intermediates between the two varieties of Sweetgrass, as reported by Fernald (1917), needs further study. If they are actually set apart by different chromosome numbers, as well as by morphological differences, the matter of intermediates requires substantiation for it is not known that the tetraploid plants will hybridize with the octoploids, although the existence of hexaploids certainly suggests that this may have occurred in the past. I have examined some 300 spikelets of specimens gathered in southern Iceland, and found in them only five viable seeds. When these were germinated they produced tetraploid seedlings which were decidedly smaller than seedlings of the octoploid Ohio specimens.

At the time polyembryony was initially reported in a population of this species in southern Michigan (Norstog, 1957), it was suggested that the specimens studied were apomicts. This has been confirmed recently by myself, although it is as yet unpublished. The 56 chromosome plants from Michigan, and probably those from Ohio, are characterized by a type of reproduction that may be exclusively aposporous and apomictic. Polyembryony is of frequent occurrence, has its origin in multiple, aposporous embryo sacs, and is, therefore, indicative of the aposporous and apomictic nature of the populations in which the phenomenon occurs. In light of the apomictic nature of the octoploid variety of *Hierochloë odorata* and the infertility of the tetraploid populations, it is obvious that the matter of intermediates between the two requires clarification.

It is interesting that Sweetgrass appears to have found a niche along the Ohio roadsides. Neither mowing nor spraying seems to affect adversely populations so located. Presumably this is because these plants usually reproduce by rhizomes, and because the herbicides used have little effect on grasses. Despite its infertility and the discontinuity of its habitat, where it has become established *Hierochloë* is quite vigorous and gives every evidence of remaining in situ indefinitely to add a touch of interest to the local scene for those who are sensitive to the variety and beauty of the grasses.

SUMMARY

Hierochloë odorata, a fragrant grass of the boreal wetlands, occurs in Ohio in a few widely scattered areas. It has been able to survive along the roadsides and railroad rights-of-way, but it is not able to withstand the drainage of its habitat and attendant intensive land usage.

The fertility of *Hierochloë* is quite low. The grass is apomictic and its propagation seems to be largely vegetative. This probably stands in the way of colonization of suitable niches unless they happen to be confluent with those in which Sweetgrass is already established.

The somatic chromosome number of *H. odorata* in Ohio was found to be 56, which supports the previously reported determination of Church (in Myers, 1947). It is suggested that the existence of two races or varieties of *H. odorata* postulated

by Fernald (1917) can be reconciled with the circumstance of the existence in North America of populations of this species having somatic chromosome complements of 28 and 56, respectively.

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